Remarks: Examination Report

It is submitted that with the amended claims herein, the objections raised against the claims are overcome.

1. Section 1 of the Examination Report

The Office Action is in response to remarks filed on 9/19/2004 and is non-final.

2. Section 2 of the Examination Report

The previous rejections of claims 44-81, 83-86, 89,112-117, and 124 have been withdrawn.

3. Section 3 of the Examination Report

Applicant's arguments with respect to claims 82, 87, 88, 96-99, 101, 116, 121-124, and 126 were not considered persuasive.

Regarding claim 82, the Examiner states that Tomisato shows carriers that each have a phase offset and produce pulses that are substantially orthogonal in time, such as with reference to figures 12(a)-12(d) in Tomisato. Tomisato states that because the carrier phase is coherent for each chip, the chips can be encoded, transmitted, and then decoded at the receiver side (column 3, lines 42-47).

Claim 82 has been amended to include some of the limitation recited in dependent claim 83 so as to better distinguish the present invention over the prior art. In particular, Claim 82 now recites a combiner (62mn) capable of combining the plurality of received multi-frequency carrier-signal components with respect to the at least one phase space to produce at least one constructive interference signal comprising at least one information signal modulated onto at least one of a plurality of pulse waveforms generated from a superposition of the at least one set of received multi-frequency carrier-signal components, the plurality of pulse waveforms being positioned substantially orthogonally in time.

Although Tomisato describes coherently combining code chips by first modulating coded data onto different coherent carriers (col. 3, lines 16-47), and then providing a receiver that performs an "**equivalent** coding to that used at the transmit side" (col. 3, lines 53-54) to decode the data, Tomisato uses Walsh codes to encode (i.e., spread) the data (col. 6, lines 26-27). If Tomisato used polyphase codes (e.g., Carrier Interferometry codes), rather than binary codes, then the receiver decoding would require a complex-conjugate coding rather than the equivalent coding recited by Tomisato.

For example, Figures 12(a)-12(d) in Tomisato show binary orthogonal functions that are well-known Walsh functions (col. 10, lines 61-65 and col. 11, lines 16-18), which are modulated onto carrier frequencies. The functions shown in Figures 12(a)-12(d) illustrate code chips modulated onto frequencies, rather than pulse waveforms in time. Each user applies a unique orthogonal Walsh function chip by chip to the individual carrier frequencies (col. 10, lines 45-49).

It is well known that binary codes such as Walsh codes applied to multicarrier (e.g., OFDM) signals **cannot produce orthogonal pulse waveforms**. Therefore, the coherent combining referred to by Tomisato cannot possibly produce a constructive interference signal comprising at least one information signal modulated onto at least one of a plurality of pulse waveforms generated from a superposition of the at least one set of received multi-frequency carrier-signal components, the plurality of pulse waveforms being positioned substantially orthogonally in time, such as recited in the Independent claim 82.

Therefore, the amended claim 82 should be found patentable under 35 U.S.C. 102(b).

Furthermore, since dependent claims 83-86 were objected to as being dependent upon a rejected base claim (Section 6 of the Examination Report), claims 83-86 should be allowed in view of the current amendment made to independent claim 82.

Dependent claims 87 and 88 are dependent upon independent claim 82, and therefore should be ruled allowable in view of the current amendment made to claim 82.

Regarding claim 96, the Examiner states that an error correcting code is used to compensate for the errors caused by the channel (col. 4, lines 32-36) and that Figure 3 shows the mapping of the multi-carrier signal at instants in time.

Claim 96 was amended to better distinguish the claimed invention over the prior art. In particular, Claim 96 now recites providing for mapping values of the <u>received</u> multicarrier signal after channel compensation at instants in time used to transmit <u>the at least one data-</u>symbol <u>value</u>. No prior-art multicarrier transmission protocol that produces a multicarrier signal having <u>at least two data symbols encoded on at least one common subcarrier and occupying at least one common symbol period simultaneously</u> that can be successfully processed by the recited "providing for mapping values" at a receiver.

In FIG. 3, Tomisato shows each subcarrier being modulated with a chip over a fraction of a data-symbol interval Ts in a frequency-hopping channel (col. 7, lines 4-16). The method Tomisato illustrates is a transmission method, rather than a receive method. Furthermore, in FIG. 3, Tomisato shows code chips (rather than different data symbols) occupying a common symbol period, but not occupying the same sub-carrier frequencies simultaneously.

Coded-modulation schemes are well-known in the art that produce a multicarrier signal in which multiple data symbols are encoded on the same subcarriers at the same time. However, coded signals produced by these prior-art modulation schemes are incapable of being decoded by mapping values of the received multicarrier signal at instants in time used to transmit the at least one data-symbol value, such as recited in the amended claim 96. Therefore, the amended claim 96 should be found patentable under 35 U.S.C. 102(b).

Regarding claim 97, the Examiner states that this is a demodulation stage that is used to recover the pulses transmitted by the chip modulator shown in Figure 8.

However, claim 97 recites "a method of receiving at least one **Carrier Interferometry signal**". The chip modulator shown by Tomisato in FIG. 8 does not produce a Carrier Interferometry signal, but rather a Walsh-coded frequency-hopped signal, such as shown in FIG. 3. As described previously, Tomisato discloses Walsh codes, not Carrier Interferometry codes. Accordingly, Tomisato's decoder requires the received signal to be multiplied by the transmitter-side code in order for coherent combining to be possible, whereas some embodiments of the present invention do not require decoding at the receiver in order to achieve coherent combining. Claim 97 is notable in that it does not recite the additional limitation of a decoder.

Therefore, claim 97 should be found patentable under 35 U.S.C. 102(b).

Similarly, claims 98 and 99 recite receivers adapted to receive at least one Carrier Interferometry signal whereas Tomisato does not. Also, the combiner recited in claims 98 and 99 does not require the additional limitation of a decoder, as required by Tomisato.

Therefore, claims 98 and 99 should be found patentable under 35 U.S.C. 102(b).

Claim 101 has been amended to recite a decision module adapted to map values of the multicarrier signal after channel compensation at instants in time used to transmit symbol values, the multicarrier signal comprising the symbol values modulated onto at least one of a plurality of pulse waveforms generated from a superposition of the at least one set of received multi-frequency carrier-signal components, each of the pulse waveforms being centered at a predetermined instant in time.

Although Tomisato describes coherently combining code chips by first modulating coded data onto different coherent carriers (col. 3, lines 16-47), and then providing a receiver that performs an "**equivalent** coding to that used at the transmit side" (col. 3, lines 53-54) to decode the data, Tomisato uses Walsh codes to encode (i.e., spread) the data (col. 6, lines 26-27). If Tomisato used polyphase codes (e.g., Carrier Interferometry codes),

rather than binary codes, then the receiver decoding would require a complex-conjugate coding rather than the equivalent coding recited by Tomisato.

For example, Figures 12(a)-12(d) in Tomisato show binary orthogonal functions that are well-known Walsh functions (col. 10, lines 61-65 and col. 11, lines 16-18), which are modulated onto carrier frequencies. The functions shown in Figures 12(a)-12(d) illustrate code chips modulated onto frequencies, rather than pulse waveforms in time. Each user applies a unique orthogonal Walsh function chip by chip to the individual carrier frequencies (col. 10, lines 45-49).

It is well known that binary codes such as Walsh codes applied to multicarrier (e.g., OFDM) signals **cannot produce orthogonal pulse waveforms**. Therefore, the coherent combining referred to by Tomisato cannot possibly produce a constructive interference signal comprising at least one information signal modulated onto at least one of a plurality of pulse waveforms generated from a superposition of the at least one set of received multi-frequency carrier-signal components, the plurality of pulse waveforms being positioned substantially orthogonally in time, such as recited in the Independent claim 101.

Therefore, the amended claim 101 should be found patentable under 35 U.S.C. 102(b).

The dependent claims 87, 88, 116, 121-124, and 126 were rejected for the reasons stated in the previous office action.

Since independent claims 82, 96-99, and 101 should be found patentable under U.S.C. 102(b), the corresponding dependent claims 87, 88, 116, 121-124, and 126 should also be deemed patentable.

4. Section 4 of the Examination Report

The rejections to Claims 102-109, 111, 127-134, and 136 were withdrawn. However, new grounds for rejection were made in view of Posner (U.S. Pat. No. 5,249,201).

5. Section 5 of the Examination Report

The dependent claims 87, 88, 116, 121-124, and 126 were rejected under 35 U.S.C. 102(b) as being anticipated by Tomisato (U.S. Pat. No. 5,504,783).

Since independent claims 82, 96-99, and 101 should be found patentable under U.S.C. 102(b), the corresponding dependent claims 87, 88, 116, 121-124, and 126 should also be deemed patentable.

6. Section 6 of the Examination Report

Claims 102-109, 111, 127-134, and 136 were rejected under 35 U.S.C. 102(b) as being anticipated by Posner (U.S. Pat. No. 5,249,201).

Claims 102-104: Claims 102 and 103 were amended to better distinguish the claimed invention over the prior art.

Regarding claim 102, the steps of "providing for mapping the data symbols to the time instants to generate a discrete signal in the time domain; and providing for generating a superposition signal by applying pulse functions to the discrete signal to produce at least one pulse modulated with one of the data symbols such that a frequency response of the digital signal sample vector includes sinusoids having non-zero values at allocated carrier frequencies, and zero values at carrier frequencies other than the allocated carrier frequencies," such as recited in claim 102, are novel. A method for generating a multicarrier signal that includes these steps is not anticipated by Posner, nor the other prior art.

Regarding claim 103, the steps of "providing for mapping the data symbols to the time instants to generate a discrete signal in the time domain; and providing for generating a superposition signal by applying pulse functions to the discrete signal to produce at least one pulse modulated with one of the data symbols such that a frequency response of the digital signal sample vector includes sinusoids having non-zero values at allocated carrier frequencies, and zero values at carrier frequencies other than the allocated carrier frequencies," such as recited in claim 103, are novel. A method for generating a multicarrier signal that includes these steps is not anticipated by Posner, nor the prior art.

Regarding claim 104, the step of "providing for impressing the at least one information symbol on the at least one pulse waveform," such as recited in claim 104, is novel. This step is not anticipated by Posner. Furthermore, claim 104 recites "a method of generating Carrier Interferometry signals," which is neither described, nor anticipated by Posner nor the other prior art.

Posner describes a technique for reducing dynamic range in a transmitted signal in which an RF input signal (e.g., a multicarrier signal) is separated into a phase-modulated carrier component (of constant modulus) and an envelope signal that expresses amplitude modulation. The phase-modulated component has a low dynamic range, and thus, is easily amplified by a non-linear power amplifier. Posner imposes the envelope back onto the phase-modulated carrier via on-off keying prior to amplification, which preserves the low dynamic range of the signal. For example, Posner uses duty factor variations of a pulse train waveform to express the envelope amplitude, which pulse-time modulates (i.e., on/off keys) the carrier signal. The resulting amplified signal has additional spectral components, which can be filtered out so as to restore the original signal's amplitude modulation after amplification.

Thus, rather than modulating data symbols onto a plurality of subcarriers to produce a multicarrier signal, Posner describes modifying an existing multicarrier signal in order to facilitate amplifying it.

Posner does not describe mapping data symbols to equally spaced time instants in the symbol duration to generate a discrete signal of mapped symbols, such as recited in claims 102 and 103.

While Posner shows a beat pattern (i.e., a pulse waveform) in FIG. 3A resulting from a superposition of two subcarriers having different frequencies, **Posner does not describe any method for modulating a data symbol onto the pulse waveform**, nor any method for modulating the subcarriers so as to produce at least one pulse modulated with one of the data symbols (such as recited in claims 102 and 103). Instead, the data symbols in Posner are simply those data symbols that were originally modulated on the individual subcarriers prior to processing by Posner. The processing described by Posner does nothing to change how the data symbols are modulated on the subcarriers so as to resemble data symbols impressed on a pulse waveform (such as recited in claim 104). Furthermore, this beat pattern is not the same "pulse train waveform" that Posner uses to modulate the carrier signal, and which is illustrated in FIGs. 6a, 6b, 7a, and 7b. Instead, Posner generates pulses in response to the envelope of a transmission signal (col. 5, lines 50-58). Consequently, this causes the frequency-response of the pulse train waveform to include out-of-band spurious signals, such as illustrated by the spectral response shown in FIG. 9.

Claims 105-106: Claims 105 and 106 were amended to better distinguish the claimed invention over the prior art.

Claims 105 and 106 recite a transmitter adapted to generate Carrier Interferometry signals including a modulator adapted to impress an information symbol onto the at least one pulse waveform.

Posner does not describe generating Carrier Interferometry signals, such as recited in claims 105 and 106.

Posner does not describe a modulator adapted to impress an information symbol onto a pulse waveform, such as recited in claims 105 and 106. Rather, Posner modulates an information-bearing carrier signal with a pulse-amplitude modulated signal. While Posner shows a beat pattern (i.e., a pulse waveform) in FIG. 3A resulting from a superposition of two subcarriers having different frequencies, **Posner does not describe any method for modulating a data symbol onto this pulse waveform.** Instead, Posner derives an on-off keyed pulse-amplitude modulation function based on the amplitude of a conventional multicarrier signal, such as a composite signal consisting of multiple subcarriers each modulated with its own data symbol. Thus, Posner's pulse-amplitude modulator cannot produce impress an information symbol onto a pulse waveform.

Claims 107-109:

Claim 107 recites an interval delay circuit adapted to provide a plurality of information symbols to prescribed time instants in a symbol duration to generate a discrete signal of symbols; and a pulse-generation circuit adapted to receive the discrete signal and generate a pulse sequence by applying predetermined pulse functions to the discrete signal, the pulse functions operating on the discrete signal such that **values of the pulse sequence at the prescribed time instants are equal to the information symbols**, and a frequency response of the pulse sequence includes sinusoids having non-zero values at frequencies within the allocated carrier set and zero values at the remaining frequencies.

Claim 108 recites an interval delay circuit adapted to receive a plurality of data symbols and map the symbols to a plurality of prescribed time instants in at least one symbol duration to generate a discrete signal of mapped symbols; and a pulse generator adapted to receive the discrete signal and generate a pulse train by **applying a pulse function to the discrete signal** wherein the pulse generator operates on the discrete signal such that a frequency response of the pulse train includes sinusoids having non-zero values at the allocated carrier frequencies, and zero values at frequencies other than the allocated carrier frequencies.

Claim 109 recites an interval delay circuit adapted to receive a plurality of data symbols and map the symbols to a plurality of prescribed time instants in at least one symbol duration to generate a discrete signal of mapped symbols; and a pulse generator adapted to receive the discrete signal and generate a pulse train by applying a pulse function consisting of a superposition of the allocated carrier frequencies to the discrete signal wherein the pulse function operates on the discrete signal such that **values of the pulse train at the prescribed time instants are equal to the mapped symbols**.

First, Posner does not describe mapping data symbols to equally spaced time instants in the symbol duration to generate a discrete signal of mapped symbols, such as recited in claims 107-109.

Secondly, while Posner shows a beat pattern (i.e., a pulse waveform) in FIG. 3A resulting from a superposition of two subcarriers having different frequencies, **Posner does not describe any method or apparatus for applying a pulse function consisting of a superposition of the allocated carrier frequencies to the discrete signal** (which comprises data symbols mapped to a plurality of prescribed time instants in at least one symbol duration). Instead, the data symbols in Posner are simply those data symbols that were originally modulated on the individual subcarriers prior to processing by Posner. Accordingly, Posner does not teach providing values of the pulse sequence at the prescribed time instants are equal to the information symbols, such as recited in Claims 107 and 109. The processing described by Posner does nothing to change how the data symbols are modulated on the subcarriers so as to resemble data symbols impressed on a pulse waveform.

Furthermore, this beat pattern is not the same “pulse train waveform” that Posner uses to modulate the carrier signal, and which is illustrated in FIGs. 6a, 6b, 7a, and 7b. Instead, Posner generates pulses in response to the envelope of a transmission signal (col. 5, lines 50-58). Consequently, this causes the frequency-response of the pulse train waveform to include out-of-band spurious signals, such as illustrated by the spectral response shown in FIG. 9.

Claim 111 recites a data source coupled to the modulator, the data source adapted to process a plurality of information symbols to generate the data symbols **with a predetermined set of phase relationships and amplitude profiles** to provide a superposition of the carriers with orthogonality in time.

While Posner shows pulses that are orthogonal in time, these pulses are not generated from data symbols generated with a predetermined set of phase relationships and amplitude profiles to provide a superposition of carriers with orthogonality in time. Rather, Posner generates duty factor variations of a pulse train in response to the envelope of a transmission signal (col. 5, lines 50-58). These duty-factor variations have nothing to do with mapping individual data symbols to pulses in a pulse train, resulting in orthogonality in time.

Therefore, the independent claims 102-109 and 111 should be found patentable under 35 U.S.C. 102(b). Furthermore, since claims 127-134 and 136 are dependent on the independent claims 102-109 and 111, respectively, they should also be found patentable under 35 U.S.C. 102(b).

7. Section 7 of the Examination Report

Claim 88 was rejected under 35 U.S.C. 103(a) as being unpatentable over Tomisato in view of Odenwalder (US 2002/0009096).

Claim 88 is dependent upon claim 82, which recites a combiner (62mn) capable of combining the plurality of received multi-frequency carrier-signal components with respect to the at least one phase space to produce at least one constructive interference signal <u>comprising</u> at least one information signal <u>modulated onto at least one of a plurality of pulse waveforms generated from a superposition of the at least one set of received multi-frequency carrier-signal components, the plurality of pulse waveforms being positioned substantially orthogonally in time</u>.

Since modulating an information signal onto a plurality of pulse waveforms generated from a superposition of sub-carrier frequencies is novel, and provides new and unexpected results, claim 82, and hence, claim 88, are non-obvious and should be considered patentable under 35 U.S.C. 103(a).

The Present Invention Reduces or Eliminates the Need for the Invention Disclosed in the Cited and Relied-Upon Reference, Tomisato.

Of particular relevance to the cited and relied upon reference, Tomisato, the present invention maps data onto orthogonal pulse waveforms, which are sequentially positioned in time. The resulting data-modulated pulse sequence is a multicarrier signal that can have low Peak-to-Average Power like a single-carrier signal. This reduces or eliminates the need for the dynamic-range reduction techniques disclosed by Tomisato.

Since the present invention solves a well-known problem in the art, and it solves this problem using new methods not disclosed nor anticipated by the prior art, Applicant submits that the Independent Claim 82 (and hence, the Dependent Claim 88) should be considered patentable under 35 U.S.C. 103.

8. Section 8 of the Examination Report

Claims 127-134 and 136 were rejected under 35 U.S.C. 103(a) as being unpatentable over Tomisato.

Applicant submits that the independent claims 102-109 and 111 should be found patentable under 35 U.S.C. 103(a), thus making the corresponding dependent claims 127-134 and 136 patentable under 35 U.S.C. 103(a).

Specifically, the independent claims 102-109 and 111 recite methods and systems for generating multicarrier signals characterized by pulse waveforms in which each pulse is

modulated a data symbol. The claimed invention produces constructive interference signals from multicarrier signals or data-modulated pulses characterized by a multicarrier spectral distribution, which no prior-art references or combination of prior-art references disclose. New and unexpected benefits are created, making the claimed invention non-obvious. For example, reduced complexity of multicarrier receiver designs are enabled, backwards compatibility with existing single-carrier signals is possible, and simultaneous benefits of optimal bandwidth efficiency and frequency diversity are achieved, which greatly improves performance.

Of particular relevance to the cited and relied upon reference, Tomisato, the present invention maps data onto orthogonal pulse waveforms, which are sequentially positioned in time. The resulting data-modulated pulse sequence is a multicarrier signal that can have low Peak-to-Average Power like a single-carrier signal. This reduces or eliminates the need for the dynamic-range reduction techniques disclosed by Tomisato.

Since the present invention solves a well-known problem in the art, and it solves this problem using new methods not disclosed nor anticipated by the prior art, Applicant submits that the independent claims 102-109 and 111 (and hence, the dependent claims 127-134 and 136) should be considered patentable under 35 U.S.C. 103.

As detailed above, the cited art describes a different type of multicarrier communication system to that claimed by the present invention. Although different to the present invention, such transmission systems have use with respect to prior-art multicarrier signaling, as is evidenced by the teaching of the prior art. Such use is served by Tomisato's transmitter and there is no teaching in the prior art to change the type of transmitter provided so as to resemble or reflect that of the present invention. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA transmitter, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

9. Prior-art references not relied upon: These references were reviewed and considered by the Applicant to be of little relevance to the claimed invention.

10. Conclusion

The Applicant submits that every effort has been made to address the Examiner's objections and that the Application is now in condition to proceed to grant.

Yours Respectfully,

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